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Extreme Compression of Heavy Ion Beam Pulses: Experiments and Modeling

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Intense heavy ion beam pulses need to be compressed in both the transverse and longitudinal directions for warm dense matter and heavy ion fusion applications. Previous experiments and simulations utilized a drift region filled with high-density plasma in order to neutralize the space-charge and current of a 300 keV K+ beam, and achieved transverse and longitudinal focusing separately to a radius < 2 mm and pulse width < 5 ns, respectively. To achieve simultaneous beam compression, a strong solenoid is employed near the end of the drift region in order to transversely focus the beam to the longitudinal focal plane. Simulations of near-term experiments predict that the ion beam can be focused to a sub-mm spot size coincident with the longitudinal focal plane, reaching a peak beam density in the range 1012 - 1013 cm-3, provided that the plasma density is large enough for adequate neutralization. Optimizing the compression under the appropriate experimental constraints offers the potential of delivering higher intensity per unit length of accelerator to the target, thereby allowing more compact and cost-effective accelerators and transport lines to be used as ion beam drivers.

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